I, Makoto Hanai, am fluent in both the English and Japanese languages. I hereby certify that I prepared the attached translation of Japanese Patent Application No. 2003-084232 and, to the best of my knowledge, it is a true and accurate translation.

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(Date)

<Type of Document> Specification

<Name of Patent> Shock-Absorbing Device of Guardrail

<Claim of Patent>

Claim 1: Shock-absorbing device of Guardrail, characterized by its way of absorbing colliding energy, which utilizes irreversible deformation of mid-filler attachment having either an ohm figured cross section or vertically opened pipe figured cross section, and connected with (attached to) support post (erected in line on ground) and guard fence (facing its back to support post and bridging each support post) by connection parts.

Claim 2: Shock-absorbing device of Guardrail, characterized by its way of absorbing colliding energy, which utilizes irreversible deformation of mid-filler attachment having either an ohm figured cross section or vertically opened pipe figured cross section and connected with (attached to) construct (erected on ground) and guard fence (facing its back to surface of construct) by connection parts.

Claim 3: Shock-absorbing device of Guardrail, utilizing shock-absorbing pipe or chock-absorbing resin, along with shock-absorbing device mentioned in Claim 1 or Claim 2.

Claim 4: Shock-absorbing device of Guardrail mentioned at Claim 2 and 3, characterized by location of construct installed, such as hydro pole, semaphoric pole, bifurcation (diverging point), anti-collision section, and sectional wall (i.e. wall at parking lot, concrete wall).

Claim 5: Shock-absorbing device of Guardrail mentioned at Claim 1 to 4 above, characterized by its cross section figure, having layered (laminated, stratified) ohm figured mid-filler attachment.

<Detail Description of the present invention>

<0001>

<Technical Area of the invention>

This invention is about shock-absorbing device, applicable to guardrail situated at (for example) median (central reservation) or parapet of a bridge. This device absorbs shock of car colliding and prevents components of guardrail, such as support post and parapet of a bridge, from collapse (falling).

<0002>

<Ordinary Method>

Ordinary, guardrail is installed at roadside in order to prevent car from

jumping into sidewalk and such, particularly in a case when driver mistook handling or when car collided and lost control, for example.

<0003>

Ordinary guardrail ("Guardrail 1") generally consists of long sheet fence ("Fence 4"), support post ("Support post 2"), and rigid mid-filler attachment ("Mid-filler attachment 6") connecting in between. And "Guardrail 1" can increase rigidity only by narrowing span of support posts and is supposing to absorb colliding energy mainly by deformation (or fall) of "Support post 2". * Refer "Figure 7"

<0004>

There are some suggestions as "building up support post by elastically recoverable elastic body" (Refer "Patent Document 1"), "housing connected several pipe into cushion cover and covering support post by them" (Refer "Patent Document 2")", and "making up with 2 kind of components, rigid face to end portion and relatively brittle face to others" (Refer "Patent Document 3").

<0005>

<Patent Document 1>

6-280222 (Claim of patent, Claim 1)

<Patent Document 2>

7-150529 (Claim of patent, Claim 1)

<Patent Document 3>

10-18257 (Figure 1 to 8)

<0006>

<Problem Solving>

Common characters, which can be found from above examples of ordinary guardrail, are "some ability to reduce shock of impact transmitting to support post by reducing speed of colliding car" and "absorbing shock by deformation or collapse of support post by increasing rigidity of guardrail as a whole whereas support post itself does not have capability of absorbing shock".

<0007>

However, if above method is to be employed, extra area for collapse of "Support post 1" is required as an appropriative area for guardrail. And if this area is not provided, then there is a possibility to harm a car running opposite side or pedestrian walking even outside the guardrail.

<0008>

Furthermore, if colliding energy was excessive, collapse of support post may increase a possibility of allowing colliding car to run upon or burst through a guardrail, which can cause secondary disaster. Also if the collapse allowed colliding car to go far from a cruising lane, that will make it difficult to lead collided car safely back to cruising lane.

<0009>

Also, in term of repairing, even if the support post was bend to opposite direction so as to bring back to vertical position, the post will be broken at bended section. Therefore, there was a necessity of re-substructure (taken up a damaged foundation and set up new support post), which is inconvenient and costly, along with replacement of breakage.

<0010>

Moreover, there is a possibility of causing secondary disaster while the damage support post was left as it is for repairing since it can be an obstacle for passage of vehicle and pedestrian.

<0011>

But if rigidity of support post was increased to reduce amount of deformation and overcome mentioned problem above, guardrail looses capability of absorbing enough colliding energy, which allows colliding shock to be transmitted and resulted in losing safety of occupant of colliding car.

<0012>

Although those which built up support post by elastically recoverable elastic body has certain ability of absorbing shock by reducing speed of colliding car (before colliding into support post), it also has a problem of causing severe secondary casualty caused by elastic (restoring) force since it will transmit elastic force to occupants of a colliding car at a time when collided car is collided and stopped.

<0013>

This present invention is made with a consideration against those problems mentioned. And it is targeted to provide a Shock-absorbing device of Guardrail, having simple structure, capability of preventing support post from falling (collapse) by absorbing shock caused by colliding of a car, and requiring less necessity of re-substructure (take up a damaged foundation and set up new support post) at a time of

restoration.

<0014>

<Method of the problem solving>

Content of this invention, as part of "Claim 1", lies on utilizing irreversible deformation of mid-filler attachment having either an ohm figured cross section or vertically opened pipe figured cross section and connected with (attached to) support post (erected in line on ground) and guard fence (facing its back to support post and bridging each support post) by connection parts in order to absorb colliding energy of a car and overcome problems mentioned above.

<0015>

Content of this invention, as part of "Claim 2", lies on utilizing irreversible deformation of mid-filler attachment having either an ohm figured cross section or vertically opened pipe figured cross section and connected with (attached to) construct (erected on ground) and guard fence (facing its back to surface of construct) by connection parts in order to absorb colliding energy of a car and overcome problems mentioned above.

<0016>

Content of this invention, as part of "Claim 3", lies on utilizing shock absorbing pipe or chock-absorbing resin along with shock-absorbing device mentioned in Claim 1 or Claim 2.

<0017>

Content of this invention, as part of "Claim 4", lies on installing (attaching) shock-absorbing device of guardrail mentioned at Claim 2 and 3 onto construct located at hydro pole, semaphoric pole, bifurcation (diverging point), anti-collision section, and sectional wall.

<0018>

Content of this invention, as part of "Claim 5", lies on utilizing mid-filler attachment characterized by its cross section figure, having layered (laminated, stratified) ohm figure, in place of mid-filler attachment (or pipe) mentioned through Claim 1 to 4 above.

<0019>

Present shock-absorbing device of guardrail can absorb colliding energy of a car by irreversible deformation of a mid-filler attachment and deformation of guardrail itself correlatively. As a result, it eases an impact of collision transmitted to support post by reducing a speed of colliding car.

<0020>

Also since present shock-absorbing device of guardrail does not employ elastic body, which transmits elastic force to occupants of a colliding car at a time when collided car is collided and stopped, it will not cause secondary casualty caused by elastic (restoring) force.

<0021>

<Implementation>

Followings are practical examples (implementation) and its detailed description of the shock-absorbing device but it is just a representative example and it will not limit a usage of the shock-absorbing device unless beyond a scope of this invention. Therefore, implementation of this invention varies with design change according to a requirement.

<0022>

"Figure 1 (a)" shows side view of shock-absorbing device (1st practical example) named "Shock-absorbing device 10". Guard fence is shown as shape of cross section. "Figure 1 (b)" is a cross-sectional view of main portion for "Shock-absorbing device 10".

<0023>

"Shock-absorbing device 10" mainly consists of "Support Post 12" (erected in line on roadside with certain span), "Guard fence 14" (facing its back to "Support Post 12" and bridging each "Support post 12"), and "Mid-filler Attachment 16" (installed in between "Support post 12" and "Guard fence 14" and connecting them). "No.1 Connection Parts 17" is connecting "Support post 12" and "Mid-filler Attachment 16". And "No.2 Connection Parts 18" is connecting "Guard fence 14" and "Mid-filler Attachment 16".

<0024>

"Support post 12" is a rust proofed steel product, having mid-air pipe figure, and fixed on roadside by mounting its under part into concrete foundation. "Through-Hole 17a" is placed at upper part of "Support post 12" so that "No.1 Connection Parts 17" can perforate "Support post 12" and connect "Support post 12" and "Mid-filler Attachment 16".

<0025>

"Guard fence 14" is a rust proofed steel product, having crooked deck plate figure. And "Through-Hole 18a" is placed so that "No.2 Connection Parts 18" can perforate in order to fix with "Mid-filler Attachment 16".

<0026>

Mid-filler attachment consists of "Colliding energy absorbing pipe 16a" (having closed elliptical cross section figure and change shape with irreversible deformation) and 2 "Arm parts 16b" (which is welded and assigned to "Guard fence 14" side). "Through-Hole 19" is placed on each "Arm parts" at corresponding position of "Through-Hole 18a".

<0027>

Though one implementation is described and explained above, this does not limit way of implementation and it can be changed due to design change. "Figure 3" shows one of the other way of implementation, installing "Colliding energy absorbing pipe 16a" between "Support post 12" and "Guard fence 14" and connecting directly by "Connection Parts 17' " and "Connection Parts 18' ". (This is named as "Shock-Absorbing Device 10' ")

<0028>

Material, size, and shape of "Support Post 12", "Guard fence 14", and "Mid-filler Attachment 16" can be changed (varied) so as to be able to lead collided car safely back to cruising lane as well as to optimize cushioning performance according to a case, such as kind of car, its colliding speed, its weight, and so on.

<0029>

When a car collided to this present guardrail, "Colliding energy absorbing pipe 16a" will have irreversible deformation, which absorb colliding energy of a car, and as a result reduce speed of colliding car. (Refer "Figure 2") In another words, possibility of "Support post 12" to be bent is reduced by absorbing colliding energy through deformation of "Colliding energy absorbing pipe 16a". Also since the colliding energy is transmitted to "Support post 12" after reduced from original state by deformation of "Colliding energy absorbing pipe 16a", "Support post 12" has less possibility of falling (orcollapse).

<0030>

Therefore, there will be less case to have a necessity of re-substructure (taken up a damaged foundation and set up new support post), which is inconvenient and costly, and it is economically superior.

<0031>

Also, even a case when excessive load was applied (i.e. when a car collided with excessive speed or when a car with excessive weight

collided) to the guardrail, colliding energy can be absorbed by deformation or collapse of support posts.

<0032>

There is a fear that if rigidity of "Mid-filler attachment" was too small or too large, it can not perform well and can not absorb the energy of colliding car in some circumstances which may leave possibility of losing safety of occupant. (Meaning of this sentence is to say that this invention can not guarantee safety of occupants for all cases.)

<0033>

"Figure 4" shows a cross-sectional view of main portion for "Shock-absorbing device 20" (2nd practical example).

<0034>

"Shock-absorbing device 20" is practically same as "Shock-absorbing device 10" apart from a points that "Mid-filler Attachment 26" is having a ohm shame which is a compose of integrated combination of "Colliding energy absorbing pipe 16a" and 2 "Arm parts 16b".

<0035>

"Figure 5" shows a cross-sectional view of main portion for "Shock-absorbing device 30" (3rd practical example) having 2 of ohm figured mid-filler members (Big: "Mid-filler member 36' ", and Small: " Mid-filler Attachment 26 ") in layers.

<0036>

Material, size, and shape of "No.1 Mid-filler Attachment 26" in 2nd and 3rd practical example, and "No.1 Mid-filler Attachment 26" and "Mid-filler member 36' " in 3rd practical example can be changed (varied) so as to be able to lead collided car safely back to cruising lane as well as to optimize cushioning performance according to a case, such as kind of car, its colliding speed, its weight, and so on. Also this present invention includes combinational implementations (structure) among 1st, 2nd, and 3rd practical example.

<0037>

In addition, shock-absorbing resin can be employed and installed within colliding energy absorbing pipe or U shape portion of mid-filler attachment. And its structure can be designed either "only the shock-absorbing resin changes shape" or "both shock-absorbing resin and colliding energy absorbing pipe or U shape portion of mid-filler attachment change shape".

(No Figure shown).

<0038>

This shock-absorbing device can be installed not only at space between support post (erected in line on ground) and guard fence (bridging several support posts) but also at hydro pole, semaphoric pole, bifurcation (diverging point), column-shaped safety drum located at bifurcation, anti-collision section in front of toll booth, and sectional building block (i.e. wall at parking lot, concrete wall) and so on. The shock-absorbing device can be attached to those construct and provide the same benefit as explained above (for example) by covering the surface (either partly or fully) with it.

<0039>

<Embodiment>

Static experimentation was carried out to find out a static performance of the mid-filler attachment. 2 kind of mid-filler attachment, "No.1 Mid-filler attachment 26" (made of SS400 steel [Height: 50mm], made by folding plate [Thickness: 4.5mm,Width: 50mm] into ohm shape) and "No.2 Mid-filler attachment 36" consists of "No.2 Mid-filler member 36' " (made of SS400 steel [Height: 100mm], made by folding plate [Thickness: 4.5mm,Width: 50mm] into ohm shape) outside and "No.1 Mid-filler attachment 26" inside, was examined by setting each attachment on base plate and applying load (kg) from above. And relation between load and change in vertical size (mm) was monitored and measured.

<0040>

As "Figure 6" shows, when 330 kg load was applied to "No.1 Mid-filler attachment 26", change in vertical size reached 5 mm, and when 710 kg load was applied, change in vertical size reached 40 mm. ("No.1 Mid-filler attachment 26" can change vertical side up to 40 mm only.)

<0041>

When 500 kg load was applied to "No.2 Mid-filler attachment 36", change in vertical size reached 20 mm, and when 865 kg load was applied, change in vertical size reached 25 mm. And "Figure 6" shows that one "No.2 Mid-filler attachment 36" is capable of absorbing colliding energy up to those equivalent of 1830 kg load.

<0042>

Material, size (thickness, width, etc.), shape, and number of "Mid-filler

attachment" to be used can be changed (varied) so as to optimize cushioning performance according to a case, such as kind of car, its colliding speed, its weight, and so on.

<0043>

<Usefulness of the invention>

Shock-absorbing device of Guardrail is having simple structure, easy put on and taken off, capability of preventing support post from falling (collapse) by absorbing shock (through deformation of "colliding energy absorbing pipe" or "mid-filler attachment") caused by colliding of a car, and requiring less necessity of re-substructure (take up a damaged foundation and set up new support post) at a time of restoration, which is economically superior.

<0044>

Also, even a case when excessive load was applied (i.e. when a car collided with excessive speed or when a car with excessive weight collided) to the guardrail, colliding energy can be absorbed by deformation or collapse of support posts which enable to lead collided car safely back to cruising lane and secure safety of its occupants.

<0045>

This shock-absorbing device can be installed at hydro pole, semaphoric pole, bifurcation (diverging point), column-shaped safety drum located at bifurcation, anti-collision section in front of toll booth, and sectional building block (i.e. wall at parking lot, concrete wall) and so on. And the shock-absorbing device can be attached to those construct and provide the same benefit as explained above (for example) by covering the surface (either partly or fully) with it.

<Description of the Figures>

<Figure 1> "Figure 1 (a)" shows side view of present shock-absorbing device. (Guard fence is shown as shape of cross section.) "Figure 1 (b)" is a cross-sectional view of main portion for the shock-absorbing device.

<Figure 2> Pattern diagram of cross-sectional view of main part showing state of present shock-absorbing device after colliding (squashed)

<Figure 3> Pattern diagram of cross-sectional view of one of the other way of implementation (embodiment) for present shock-absorbing

device

<Figure 4> Pattern diagram of cross-sectional view of main part showing one of the other way of implementation (embodiment) for present shock-absorbing device

<Figure 5> Pattern diagram of cross-sectional view of main part showing one of the other form of mid-filler attachment, composing present shock-absorbing device

<Figure 6> Graph showing a result of Static experimentation of present shock-absorbing device: horizontal axis represents change in vertical size (mm), vertical axis represents load (kg) placed on top surface

<Figure 7> "Figure 7 (a)" shows pattern diagram of side view of ordinary guardrail. (Guard fence is shown as shape of cross section.)
"Figure 7 (b)" shows cross-sectional view of main for ordinary guardrail ("Figure 7 (a)").

<Description of code>

1: Ordinary Guardrail
2: Support Post
4: Guard Fence
6: Ordinary Mid-filler Attachment
10: Present Shock-absorbing device (1st example)
10' : Present Shock-absorbing device (other example)
12: Support Post
14: Guard Fence
16: Mid-filler Attachment
16a: Colliding energy absorbing pipe
16b: Arm Parts
17: No.1 Connection Parts
17' : Connection Parts
17a: Through-Hole
18: No.2 Connection Parts
18' : Connection Parts
18a: Through-Hole
19: Through-Hole
20: Present Shock-absorbing device (2nd example)
26: No.1 Mid-filler Attachment having ohm figure

30: Present Shock-absorbing device (3rd example)

36: No.2 Mid-filler Attachment having layered ohm figure

36' : No.2 Mid-filler member having ohm figure

<Type of Document> Summary

<Summary>

<Aim>

Aim of this invention is to provide shock-absorbing device of guardrail, having simple structure, easy put on and taken off, capability of preventing support post from falling (collapse) by absorbing shock caused by colliding of a car, and also requiring less necessity of re-substructure at a time of restoration.

<Proposing Solution>

"Shock-absorbing device" mainly consists of "Support Post 12" (erected in line on roadside with certain span), "Guard fence 14" (facing its back to "Support Post 12" and bridging each "Support post 12"), and "Mid-filler Attachment 16" having an ohm figured cross section or vertically opened pipe figured cross section (installed in between "Support post 12" and "Guard fence 14" and connecting them). "Support post 12" and "Mid-filler Attachment 16" is connected by "No.1 Connection Parts 17", and "Guard fence 14" and "Mid-filler Attachment 16" is connected by "No.2 Connection Parts 18". And "Shock-absorbing device" is designed to absorb colliding energy of a car by irreversible deformation (plastic deformation) of a mid-filler attachment. Apart from support post, the shock-absorbing device can be installed at hydro pole, semaphoric pole, bifurcation (diverging point), column-shaped safety drum located at bifurcation, anti-collision section in front of toll booth, and sectional building block (i.e. wall at parking lot, concrete wall) and so on. And the shock-absorbing device can be attached to those construct and provide the same benefit as explained in specification by covering the surface (either partly or fully) with it.

<Figure>

Figure 1